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PATENT SPECIFICATION

337,205

Application Date: Nov. 5, 1929. No. 33,594/29.

Complete Accepted: Oct. 30, 1930.

COMPLETE SPECIFICATION.

Improvements in connection with Boiler Feed Pumps.

We, G. & J. WEIR, LIMITED, of Holm Foundry, Cathcart, Glasgow, a British Company, and CHARLES RUSSELL LANG, a Director of the said Company, of the same address, a British Subject, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The present invention relates to the supply of feed water to boilers.

The requirements of a boiler as regards feed water are in general variable; and it is necessary for the feed pump to be able to supply at a variable rate. Moreover it is generally desirable that the feed be controlled automatically according to the boiler water level or steaming rate. Methods of varying the output of the feed pump automatically in accordance with its pressure of delivery are in use at present and are well known.

Now it is often desirable to alter the output of the feed pump without alteration of the speed at which it is driven. For example, in the case of a pump driven by an A.C. electric motor, it may be desirable to have an arrangement whereby the pump output can be varied while the motor runs at constant speed.

The output of a pump can be altered without altering the speed—i.e. the number of cycles in a given time—by employing two or more plungers, pistons, or other positive displacers, and altering the relative movements of these displacers, their absolute movements remaining unchanged.

For example the pump may be formed with a body or holder containing fluid, an admission and a discharge valve—or other means for controlling the flow of the fluid into and out of the said body—and a pair of equal co-acting displacers which act within the said body to vary the net volumetric capacity or fluid content of the same.

By altering the relative movements of these co-acting displacers, the output of the pump can be varied from the maximum to zero, or approximately zero.

Methods of altering the relative movements of such co-acting displacers, or their phase relationship, for this object are known. See for example the specifications of Applications for Patents Nos. 20,361 of 1929 (Serial No. 335,932) and 32,806 of 1929 (Serial No. 336,810). It has also been proposed to have the shafts interconnected by "differential" gearing and to drive them by synchronous electric motors.

The present invention consists in means for varying the output of a pump on the lines above-mentioned and doing this automatically in accordance with its pressure of delivery in a manner which will be described in describing two convenient manners of carrying the invention into effect. The accompanying drawings are provided to illustrate these manners and the invention generally. These drawings are diagrammatic. In both cases the pumps are boiler feed pumps.

In the construction as illustrated (diagrammatically) in Figs. 1 and 2, the angular position of one of the shafts with respect to the other is altered by giving a motion of partial rotation to the stator of a synchronous electric motor which drives one of the shafts, the other shaft being driven by a similar synchronous motor.

In the construction as illustrated (diagrammatically) in Figs. 3 and 4, the angular position of the one shaft with respect to the other is altered by movement of gear wheels through which one of the shafts is driven, the two shafts being interconnected by gearing.

Referring to the construction illustrated (diagrammatically) in Figs. 1 and 2, in Fig. 1 the two shafts are shown in phase, that is, with a phase difference or phase displacement of nil: in Fig. 2 they are shown with a phase difference of 180°.

a is the pump body or holder, *b* the admission valve, and *c* the discharge valve. *d*, *e* are the two displacers: they are driven respectively by the shafts *f*, *g* by means of the cranks *h*, *k*. The shafts are driven respectively by the electric motors *m*, *n*. The stator of the electric motor *n* can, in order to alter the phase relationship of the two shafts, be

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given a motion of partial rotation by means of a small electric motor *o* carrying a worm *x* which meshes with the worm wheel *z* which is coupled to the stator of the motor *n*.

The supply of actuating electric current to the small electric motor *o* is controlled in accordance with the pressure of delivery of the pump as follows.

11 is a cylinder connected by the pipe 12 to the water delivery pipe from the pump to the boiler on the pump side of the boiler regulator valve. In the cylinder is a piston 10 which is connected by the rod 13 to the lever 14 which carries an electric contact member 15 adapted to engage with the electric contacts 16, 17 and the electric contacts 18, 19. When in engagement with the contacts 16, 17, it closes the electric circuit 20 whereby the motor *o* is caused to rotate in a certain direction. When in engagement with the contacts 18, 19, it closes the electric circuit 21 whereby the motor *o* is caused to rotate in the opposite direction.

According therefore to the pressure in the water delivery pipe between the pump and the boiler regulator valve, the motor *o* is rotating in one direction, is at rest, or is rotating in the other direction. The apparatus may be so arranged that the one-direction rotation or the other-direction rotation of the motor are put in operation with a definite and small pressure difference, say ten pounds per square inch.

When the two shafts are in phase—as in Fig. 1—the co-operative displacement of the two displacers is a maximum. When the phase difference of the two shafts is 180°—as in Fig. 2—the co-operative displacement of the two displacers is approximately zero. (A slight variation from zero may be obtained due to obliquity of driving or connecting rods), and the output of the pump is nil, or practically so. With any phase difference between zero and 180° there is a corresponding pump output between nothing and the maximum.

The displacers were referred to above as being "equal co-acting". By this is meant that they have an equal displacement effect. It will in general be desirable to make them and work them exactly similarly; but precise similarity is not of course essential provided that their displacement effect is the same.

The throw or movement of each displacer will be obtained generally by a crank on its driving shaft, but it might be by an eccentric or other mechanical device generally equivalent to a crank.

The two shafts are shown in Figs. 1 and 2 in a "position of opposition" to each other. By a "position of opposition" is meant that the shafts are on opposite sides of the body or holder and such that they drive the displacers in coincident or parallel lines but in opposite directions.

The two shafts may however if desired be arranged in alignment with each other or in any other way as may be convenient or desirable.

However the shafts are arranged, the expression "phase difference" is of course used in this specification to refer to the relative positions or conditions of the two shafts as regards their action on the displacers; that is, for example, the shafts would be considered to be in phase if the inmost positions which they gave to the displacers occurred at the same instant.

Under normal running conditions the two displacers will run with a phase difference which will vary in amount. Under full load conditions the displacers will be in phase, with a consequent maximum pumping effect. Under no load conditions the displacers will have a phase difference of 180° and the pump discharge will be nil.

When the boiler is working normally and then a sudden overload demand reduces the water level, the boiler regulator valve opens (that is, it opens from a shut position, or increases its opening). The pressure on the admission or pump side of the valve is therefore reduced, and this reduction in pressure actuates the piston 10 so as to make the necessary electrical contact as before described and start the small electric motor *o* to run in the required direction. When the pressure under the valve rises again to a certain value, the motor regulator contact is broken and the motor stops. The phase relationship between the two shafts then remains in the position in which it is.

Whenever there occurs a further fall in boiler water level or a rise in this level, the piston 10 is again actuated so as to start the motor *o* and make it run in the one direction or the other as required, so altering the phase relationship of the two shafts.

The phase relationship of the two shafts might if desired be varied by moving the stator of both motors (*m*, *n*) instead of only one (*n*).

Referring now to the construction shown in Figs. 3 and 4, in Fig. 3 the two shafts are shown in phase, that is, with a phase difference or phase displacement of nil: in Fig. 4 they are shown with a phase difference of 180°.

a is the pump body or holder, *b* the admission valve, and *c* the discharge valve.

d, *e* are the two displacers: they are driven respectively by the shafts *f*, *g* by means of the cranks *h*, *k*. *m* is a motor or power means (of any suitable nature) which drives the pump. It drives the shaft *n* which carries the gear wheel *r*. This gear wheel meshes with the gear wheel *s* on an intermediate shaft *t* which shaft also carries a gear wheel *u* which meshes with a gear wheel *w* on the shaft *g*. The gear wheel *r* also meshes with a gear wheel 2 which in turn meshes with a gear wheel 3 carried by an intermediate shaft 4 which also carries a gear wheel 5 which meshes with the gear wheel 6 on the shaft *f*.

The intermediate shaft *t* is carried by a frame or carrier *v* which is mounted to swivel about the axis of the shaft *n*. It is so swivelled by means of a small electric motor *o* carrying a worm *x* which drives a worm wheel *z*, carried by the carrier *v*. It will be obvious that, by swivelling the intermediate shaft *t* with its gear wheels, the phase relationship of the shafts *f* and *g* will be altered.

The supply of actuating electric current to the small electric motor *o* is controlled in accordance with the pressure of delivery of the pump by means of the cylinder 11 and piston 10 as described with reference to Figs. 1 and 2.

Except for the difference in the driving of the shafts *f* and *g* and in the means employed for altering their phase relationship, the remarks made with reference to the arrangement shown in Figs. 1 and 2 apply in general to the arrangement shown in Figs. 3 and 4.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. Varying the output of a pump automatically in accordance with its pressure of delivery, by altering the phase relationship of two shafts by an electric motor which acts to alter the angular position of one of the shafts with respect to the other, characterised by the fact that the supply of electric energy to this motor is controlled, substantially in the manner described, by a member affected by the pressure of delivery of the pump.

2. Varying the output of a pump automatically in accordance with its pressure of delivery as set forth in Claim 1, further characterised by the fact that the said electric motor controls the angular position of the stator of an electric motor which drives one of the said shafts, substantially as described.

3. Varying the output of a pump automatically in accordance with its pressure of delivery as set forth in Claim 1, further characterised by the fact that the said electric motor controls the position of a gear wheel carrier which is arranged to swivel about the axis of one of the said shafts and so controls the angular position of this shaft with respect to the other, substantially as described.

Dated the 2nd day of November, 1929.

R. M. NEILSON,
Atlantic Chambers, 45, Hope Street,
Glasgow,
Chartered Patent Agent.

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[This Drawing is a reproduction of the Original on a reduced scale.]

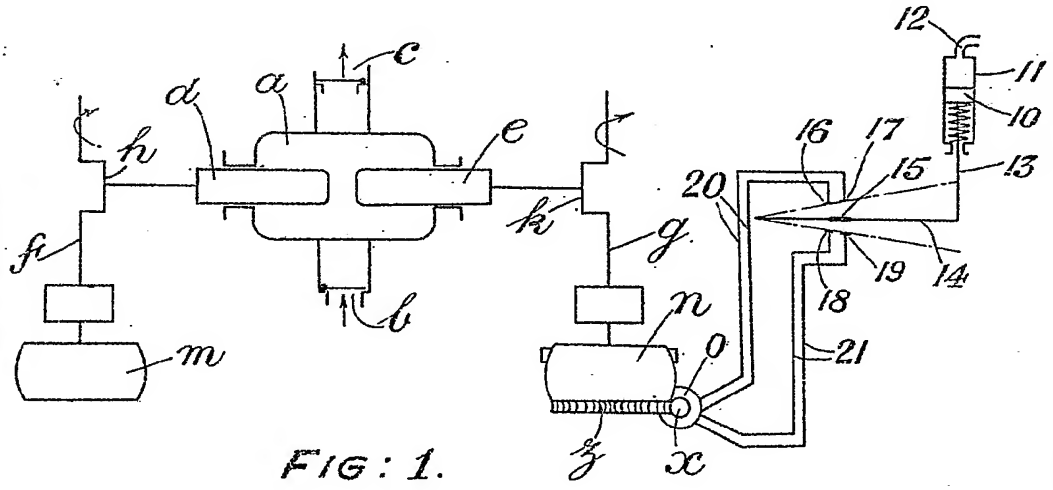


FIG: 1.

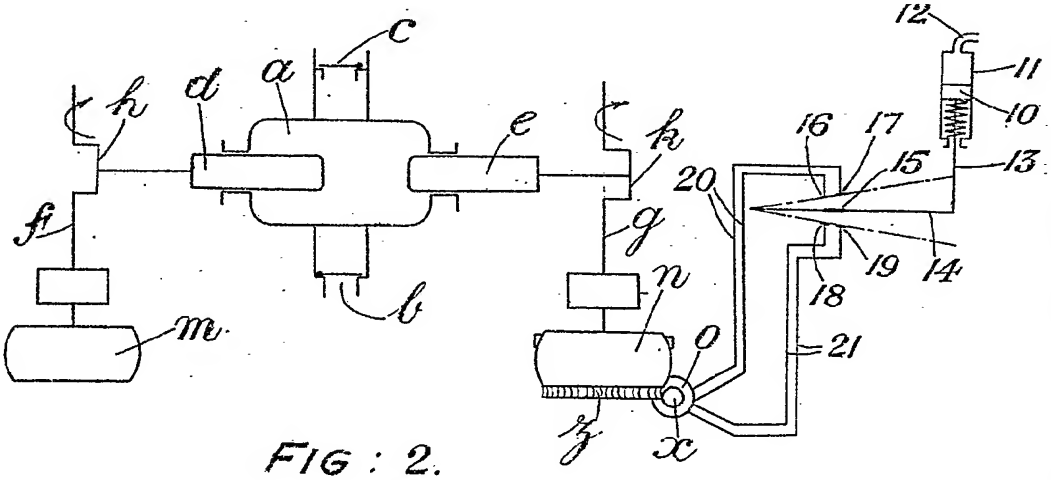
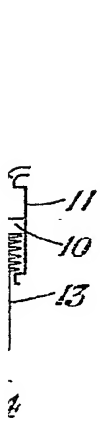


FIG: 2.



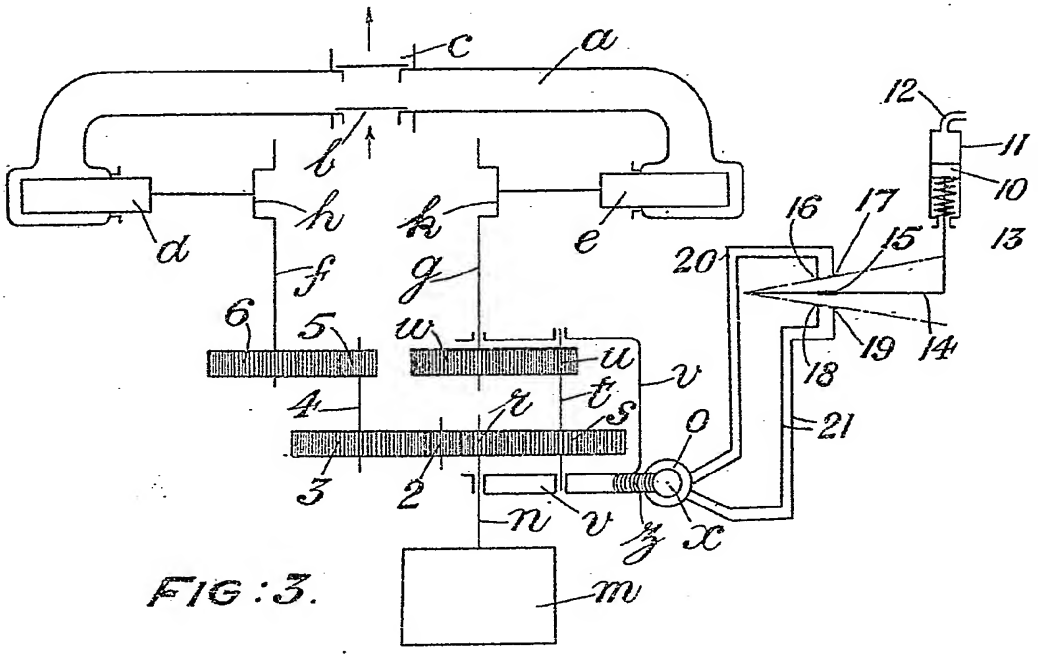
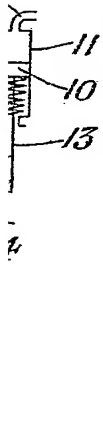


FIG: 3.



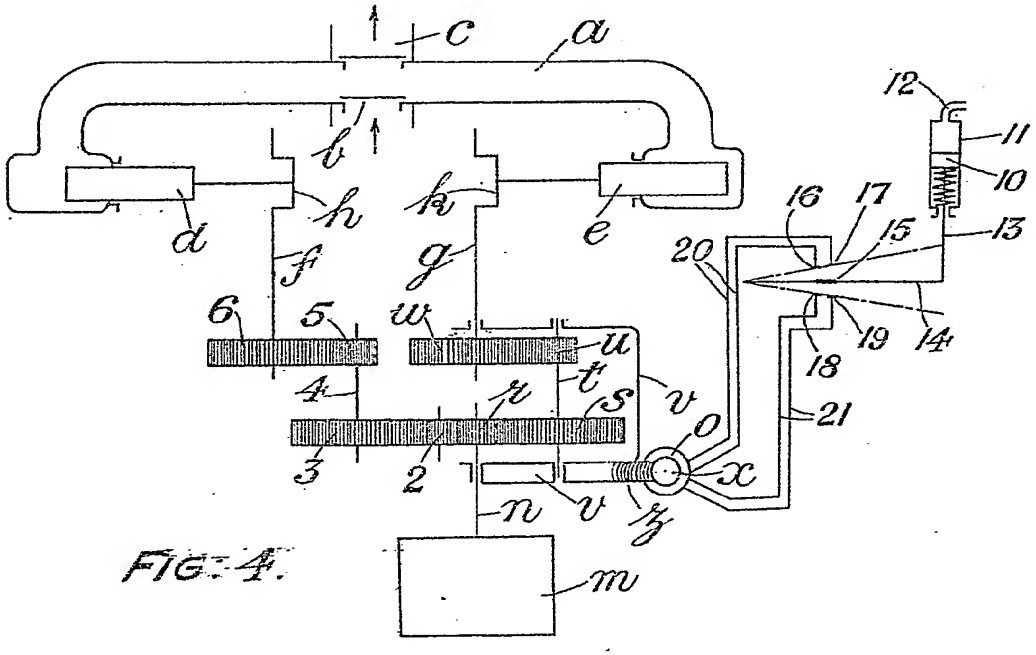


FIG: 4.

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337,205 COMPLETE SPECIFICATION

2 SHEETS

SHEET 1

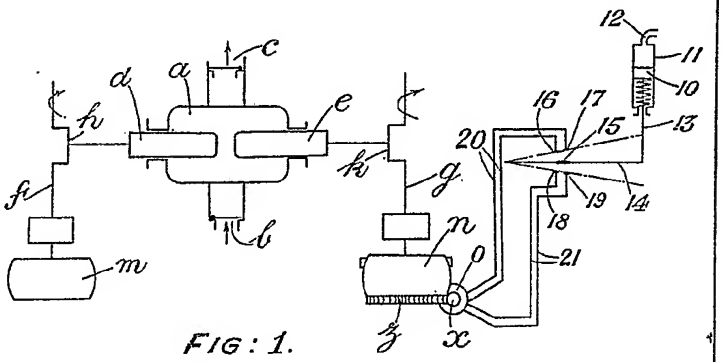

FIG: 1.

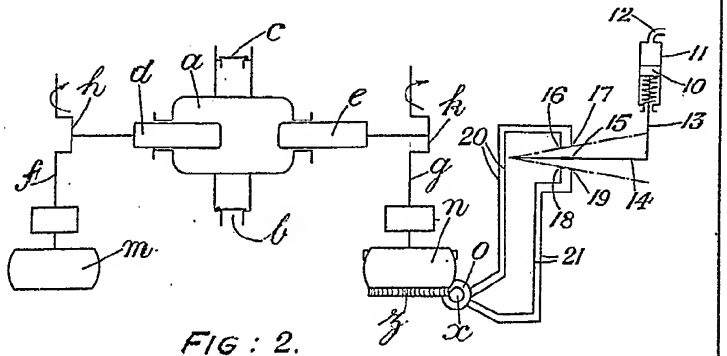

FIG: 2.

SHEET 2

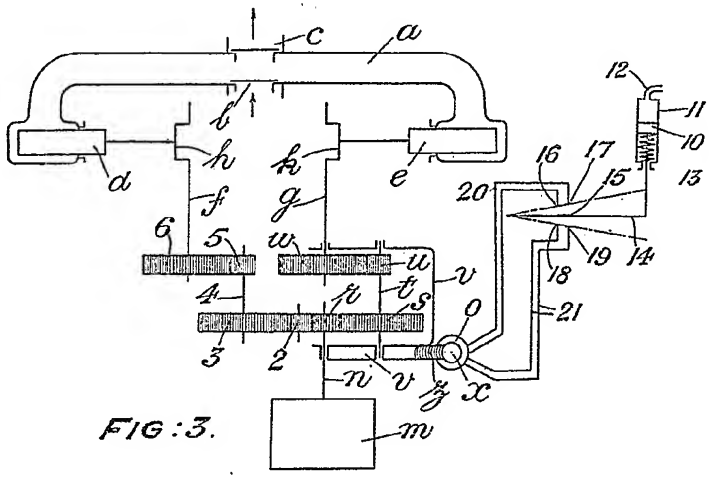

FIG: 3.

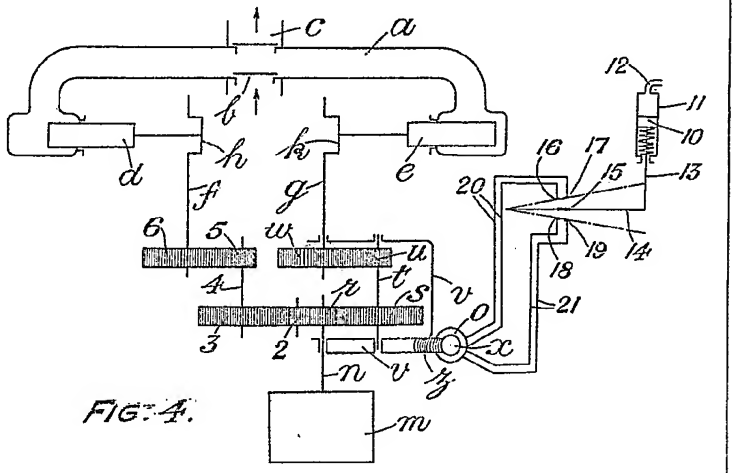

FIG: 4.

[This Drawing is a reproduction of the Original on a reduced scale]

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